

HEROShapers®: the adapted pitch concept

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The adapted pitch concept involves varying the pitch and the length of the cutting portion as a function of the taper of the instruments. By modifying these parameters, it is possible to select the instrument with the strength, efficacy, flexibility, and taper best suited for the root canal being prepared. In the HEROShaper® sequence, instruments with a 0.06 taper are used to prepare and enlarge the coronal and middle thirds of the canal. These instruments have a longer pitch for enhanced flexibility and dentine cutting efficacy. The removal of dentinal chips is facilitated and the tendency to screw in is reduced. Instruments with a 0.04 taper are used to prepare the apical portion because they have a shorter pitch and cutting portion (12 mm), which makes them stronger and more flexible. They can thus negotiate apical curvatures without deviating from the initial canal axis. The files are used in a continuous rotation mode (450–600 r.p.m.) to progressively prepare the root canal (crown-down). The sequences are selected based on the difficulty of the original canal shape.

Background

For root canal preparation using nickel–titanium (NiTi) instruments in continuous rotation, various generic concepts have been developed:

- the greater taper of the cutting portion makes it possible to use the crown-down technique,
- the rotation speed is low (350–600 r.p.m.),
- little or no pressure needs to be exerted on the head of the handpiece,
- the light in and out movement limits the engagement of dentine between the instrument and the canal walls.

Three essential rules must be followed when using the HERO 642 (Micro-Mega, Besançon, France) – the first rotary NiTi instrument designed without radial lands:

- the difficulty of the case, including consideration of the canal curvature, and degree of dentine mineralization determine the most suitable sequence
- the correct levels of penetration for each taper must be respected
- circumferential shaping of the canal is achieved using a brushing motion.

Recently a new canal preparation instrument – the HEROShaper® (Micro-Mega) – was designed with the same triple-helix cross-section. The key modifications

in this instrument involve the pitch of the blade and the length of the cutting portion, which vary depending on the taper. By modifying these parameters, it is possible to select the strength, efficiency, and flexibility best suited for the taper and the work required of the instrument – this is the ‘adapted pitch’ concept.

Instrumentation

Two instruments with different tapers (0.06 and 0.04) and three tip diameters (#20, #25, and #30) are used in the HEROShaper® sequence. All have a triple-helix cross-section with a positive cutting angle (Fig. 1).

Increasing the blade pitch changes the properties of the instrument and thus its behavior during continuous rotation:

- the longer the pitch, the greater the flexibility (Table 1),
- the smaller the blade angle, the greater the cutting efficiency. Under identical working conditions, rotation speed, and pressure, an instrument with a long pitch will shape a canal more quickly than an instrument with a short pitch,
- debris evacuation, i.e. dentinal chips, is facilitated by the longer pitch because evacuation is more direct,
- the threading-in phenomenon is reduced.



Fig. 1. Shape of the blades of the HEROShaper® (cross-section).

Table 1. Force (g) exerted on the handle of triple-helix files with a 0.06 taper required to deflect them by 45° when 3 mm of the tip is clamped in a chuck (ANSI ADA No. 28 standard)

Pitch dimension	Tip diameter		
	#20	#25	#30
Short: 0.57–0.99	27	38	63
Long*: 0.87–1.50	47	62	109

*HEROShaper®.

Table 2. Force (g) exerted on the handle of a HEROShaper® with a 0.04 taper and #20 tip diameter required to deflect it by 45° with 3, 5, 7 and 9 mm (λ) of the tip clamped in a chuck

Length of tip clamped (λ, mm)	Force exerted on the handle	
	16 mm cutting portion	12 mm cutting portion
3	26	21
5	56	39
7	103	64
9	162	98

The length of the cutting portion is the second parameter than can be varied to modify the behavior of the instrument. Decreasing the length of the cutting portion increases flexibility (Table 2). The shank connecting the handle to the cutting portion is

narrower. The contact between the file and the canal is reduced and is limited to the area of the canal being prepared.

Clinical consequences

With the crown-down technique, the canal is progressively cleaned, enlarged, and shaped from the crown to the apex. With the HEROShaper® technique, an instrument with a greater taper is used first and is followed by one with a smaller taper in order to progressively shape the canal. A short cutting portion is used to enlarge the canal. The entire length of the cutting portion of the instrument is rarely in contact with the canal wall at the same time. This considerably reduces resistance, which is much higher with continuously rotating instruments. The tip is inactive and only serves as a guide to keep the instrument centered in the canal (Fig. 2). Each portion of the canal is prepared using a specific instrument. The preparation begins with an instrument having a 0.06 taper to enlarge the coronal and middle thirds of the canal.

Since the total mass of instruments with a 0.06 taper is substantial, the pitch of the blades is lengthened to reduce rigidity (Table 3). The pitch also progressively decreases from the shank to the tip. The length of the cutting portion is 16 mm. Where possible, it is preferable to use short instruments (21 mm total length) in order simplify access to the canal. Lengthening the pitch increases flexibility and cutting efficiency. These instruments can thus negotiate canal curves

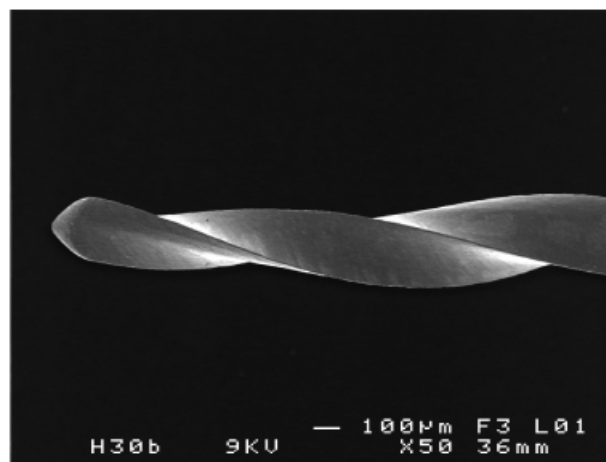


Fig. 2. Tip of the HEROShaper®: the tip is inactive and serves to guide the file, keeping it centered in the canal (micrograph courtesy of Dr A. Dautel).

Table 3. Pitch length (mm) of the blades of a HEROShaper® as a function of taper and tip diameter

Characteristics of the HEROShaper®		Level of measurement		
Taper	Size	Tip	10 mm	16 mm
0.04	#20 and #25	0.57	0.83	0.99*
0.04	#30	0.70	1.01	1.20*
0.06	#20, #25 and #30	0.87	1.26	1.50

The pitch length increases progressively from the tip to the shank. The pitch length is that of the tip of files with a 0.06 taper (10 and 16 mm tip diameter).

*Theoretical calculations.

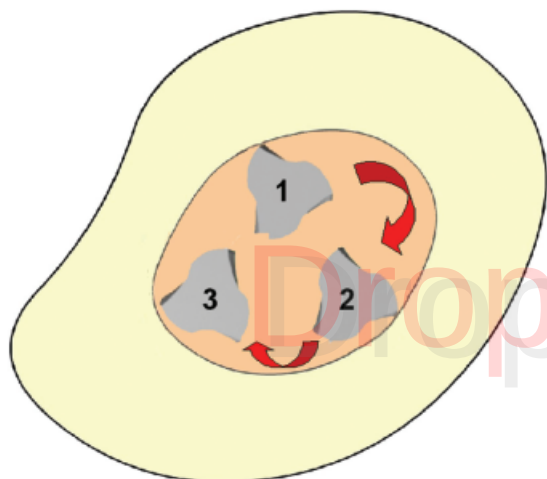


Fig. 3. Brushing technique: the file is lightly pressed against the walls to prepare the entire root canal surface while respecting the original anatomy.

while respecting the initial axis. The evacuation of dentinal chips is also facilitated and the screw-in effect reduced markedly.

The anatomy of the apical portion of the canal can be complicated with oval and flattened areas. Once the level of penetration is attained, it is necessary to prepare all the canal walls using a brushing motion (Fig. 3).

Flaring of the coronal two-thirds of the canal will facilitate penetration of the apical portion, which can be accomplished using HEROShaper® instruments with a 0.04 taper (Fig. 4). Their shape is well adapted for negotiating this particularly difficult portion of the canal. Since the core diameters of these instruments are smaller to reduce the risk of twisting, the blade pitch is

shorter than that of instruments with a 0.06 taper. This effect is accentuated with instruments having smaller tip diameters (Table 3).

On the other hand, to increase flexibility, the cutting portion can be reduced to 12 mm. This provides a flexible instrument that can better negotiate apical curves while respecting the original canal axis.

Operating technique

Choice of sequence

The operating sequence is chosen as a function of the difficulty of the clinical case and is based on two criteria:

- The diameter of the root canal (narrow or large).
- Canal curvature (slight or pronounced).

Pre-operative radiographs are used for a preliminary evaluation of the clinical case. A second, more specific evaluation is obtained during the initial negotiation with a conventional hand file.

Three different sequences are recommended (Table 4)

For simple cases, a single sequence (the ‘blue wave’) using two #30 files with decreasing tapers is recommended, the first with a 0.06 taper and the second with a 0.04 taper. The small canal curvatures and sufficiently large canal lumen allow a #15 K-file to penetrate to the apex.

Intermediate cases are prepared using the ‘red wave’. #25 files with 0.06 and 0.04 tapers are followed by a #30 file with a 0.04 taper (Fig. 5). Canals of average difficulty have a moderate curvature and more pronounced mineralization of the canal lumen. Penetration with a #10 K-file to the apex may be difficult (Fig. 6).

Difficult cases are treated using the ‘yellow wave’. #20 files with 0.06 and 0.04 tapers are followed successively by a #25 file with a 0.04 taper and a #30 file with a 0.04 taper to full working length. Difficult canals are severely curved, occasionally with substantial mineralization, making first penetration problematical even with very small files.

Canal preparation

HEROShapers® are used with continuous rotation. The rotation speed must be kept constant and not

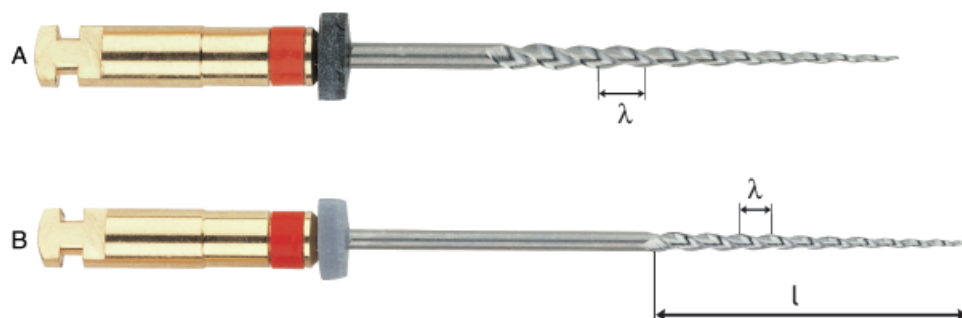
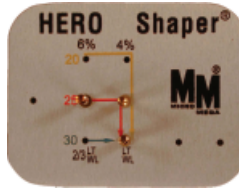
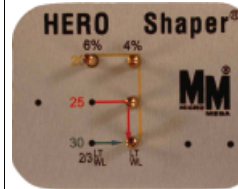


Fig. 4. HEROShaper[®] #25 (25/100 tip diameter) with 0.06 (A) and 0.04 (B) tapers. To facilitate access to the canal, a 21-mm-long file with a 0.06 taper should be used, when possible. λ = instrument pitch, l = reduced length of the cutting portion = 12 mm (0.04 tapers).

Table 4. The three HEROShaper[®] sequences

Difficulty		Easy Cases		Intermediate Cases		Difficult Cases	
Curvature		Slight		Moderate		Severe (+20°)	
Canal							
Taper		.06	.04	.06	.04	.06	.04
Penetration		2/3 WL	WL	2/3 WL	WL	2/3 WL	WL
Tip Diameter	#20					1 → 2	
	#25			1 → 2			3
	#30	1 → 2			3		4
							

exceed 600 r.p.m. Micro-motors with an adjustable torque do not necessarily have to be used. A simple solution is to attach a gear-reduction handpiece to the motor of the unit.

The canal orifice must be located and an access cavity prepared by removing all coronal interferences. The canal orifice must be opened and preferably

enlarged. A pre-operative radiograph is used to estimate the working length. The first penetration with a #10 K-file (MMC[®], Micro-Mega) coupled to an electronic apex locator will confirm the first evaluation.

The working length can be re-evaluated once the coronal two-thirds has been prepared.

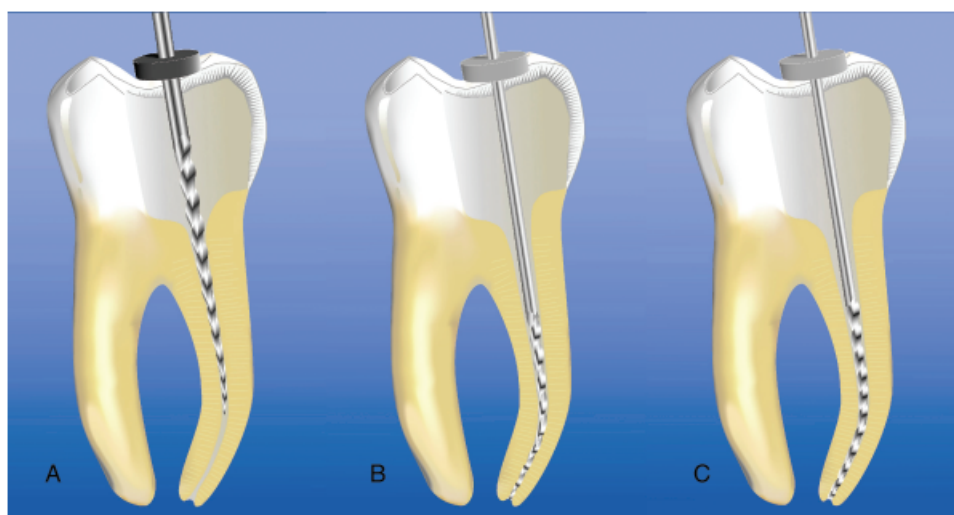


Fig. 5. HEROShapers® intermediate sequence: A, 0.06 #25: 2/3 WL; B, 0.04 #25: WL; C, 0.04 #30: WL.

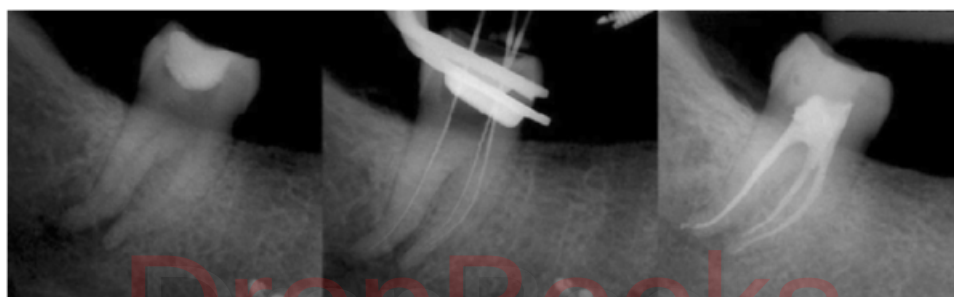


Fig. 6. Clinical treatment of a molar using the instruments of the intermediate sequence.

The HEROShaper® is positioned at the canal orifice and is inserted to the selected penetration level at a constant rotation speed using a slow, regular, short in-and-out movement. Only very light pressure must be exerted on the handpiece. The instrument is simply inserted into the canal and then rotated.

The waves described above must be respected by not exceeding the penetration levels of the files, i.e. 0.06 at 2/3 WL and 0.04 at WL. However, if the anatomy of the canal allows (moderate curve, large canal) a 0.06 instrument to penetrate to the apex, it may not be necessary to use the 0.04 instruments.

It is important to thoroughly irrigate the canal during this preparation phase. The irrigation must begin as the coronal access cavity is prepared. The pulp chamber must always be full of irrigating solution and pulp debris and dentine chips must be constantly evacuated by irrigating between each passage of a file. In addition, if the root anatomy is complex, recapitulation with a #10 K-file between each passage of a preparation file is



Fig. 7. The sequencer makes it easier to respect the operating sequences. A cursor on the cover of the storage box helps keep track of the number of preparations performed with the kit.

recommended. The hand file can even be pushed slightly beyond the apical preparation limit to maintain apical patency.

When the instruments are placed in the sequencer, it is easy to follow the correct order for each wave (Fig. 7). A colored ring and the color of the stop make it possible to identify each instrument based on tip diameter and taper: 0.06 taper (black stop), 0.04 taper (gray stop). In addition, the handles of these instruments are short (11 mm) to facilitate access to posterior teeth.

As with all mechanized Ni-Ti file procedures, the risk of breakage must be taken into consideration. In addition to respecting the instrument sequence and the penetration levels, no pressure should be applied on the head of the handpiece, and a constant rotational speed must be used. The pitch of the blades must also be carefully monitored and any instruments that become deformed because of over-use must be discarded.

Management of the extremities of the canals

The canal orifice of adult teeth is often narrow and mineralized. This phenomenon is more marked in the mesial and buccal canals of molars and may result in

complications because the axis of the canal may be curved (Fig. 8).

Enlarging the canal orifice facilitates canal preparation and filling. This can be achieved by using a special instrument at the beginning of the sequence, the

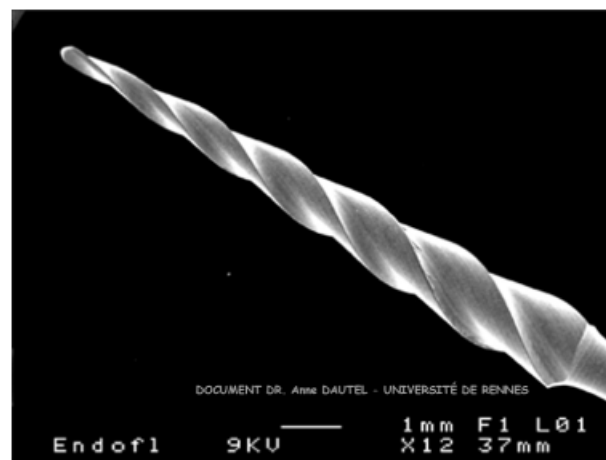


Fig. 9. Cutting portion of the Endoflare: the longer pitch increases the cutting capacity of the blades and facilitates the removal of dentin chips (photograph courtesy of Dr A. Dautel).

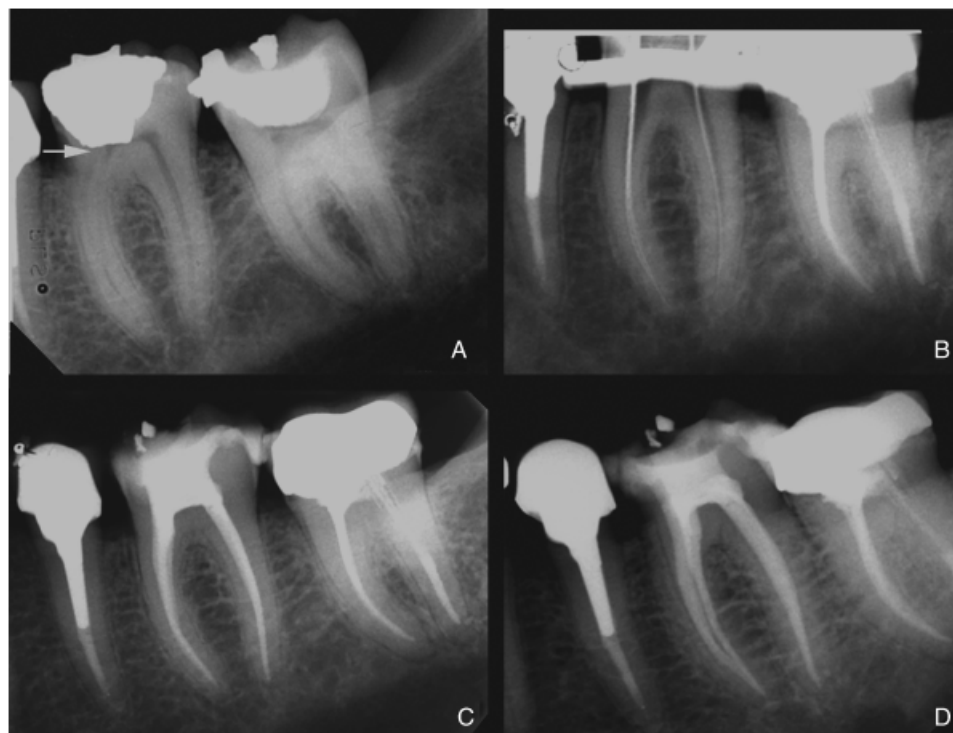


Fig. 8. Canal treatment of a mandibular lower first molar. (A) Pre-operative radiography. Note the dentine at the orifice of the mesial canal (arrow). (B) Pre-operative radiograph. The Endoflare has enlarged the canal orifice. The file used for the first penetration can now negotiate the apical canal curvature without being blocked in the coronal portion. (C, D) Post-operative radiograph in two angulations.

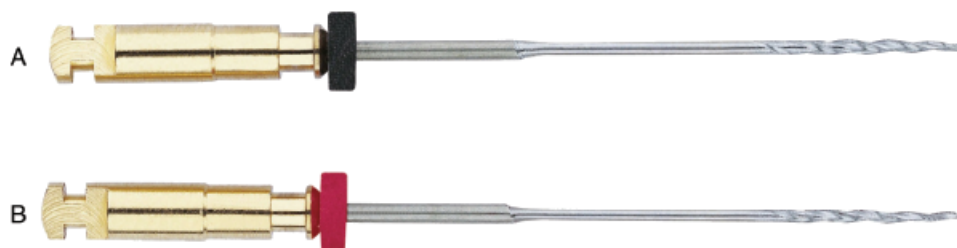


Fig. 10. HERO Apical® files 0.06 (A) and 0.08 (B): the short cutting part is connected to the handle by a fine, flexible shank.



Fig. 11. Treatment of the root canals (46) with necrotic infected pulp. To facilitate pre-operative disinfection, the canals were enlarged down to the apical portion (HERO Apical®). Follow-up radiograph 6 months after filling.

Endoflare™ (Micro-Mega). It has a #25 tip diameter, a 0.12 taper, a 10 mm working length and a 15 mm total length (Fig. 9).

The EndoFlare™ should be used at the beginning of the sequence following the first use of manual files. Short, slow, in and out movements and delicate axial pressure on the head of the handpiece are used to penetrate the coronal third of the canal. These instruments must not penetrate more than 3 mm.

In a second step, the canal orifice can be selectively enlarged. The continuously rotating instrument should be pressed lightly against various parts of the canal walls to selectively eliminate dentine in this area.

The remainder of the canal preparation is based on conventional sequences selected as a function of the difficulty of the clinical case.

The apical portion of the canal is prepared with the last file in the sequence, a 0.04 taper # 30.

However, on occasions it is necessary to use specific instrumentation, the HERO Apical® (Micro-Mega). This is a rotating, Ni-Ti, triple-helix file with three cutting edges, similar to the HEROShaper®. The long pitch prevents the screwing in phenomenon, increases the cutting action, and facilitates the excision and evacuation of dentine chips. A special feature is the short working length (4 mm), which is connected to

Table 5. Penetration of the HERO Apical® as a function of root anatomy

Anatomical features	HERO Apical® #30	
	0.06 taper	0.08 taper
Large roots	WL	WL
Narrow roots	WL	WL-1 mm
Very narrow, curved roots	LT-1 mm	LT-2 mm

the handle by a fine, flexible shank (Fig. 10). It can thus negotiate canal curves without difficulty.

The HERO Apical® has a size 30 tip diameter and is available with 0.06 and 0.08 tapers and is suited for larger canals. In canals with necrotic pulps, it is ideal for removing dentine contaminated with bacteria. It also flares the apical third, facilitating filling (Fig. 11). The file with the 0.06 taper can be followed by the 0.08 taper. However, the 'step-back' technique should be used with narrow roots to avoid weakening them (Table 5).

Conclusions

One of the advantages of using HEROShaper® sequences is that a limited number of files are required: two for easy cases and four for complex cases. In

addition, the instruments are only used once during the preparation of a canal. The sequence is thus simpler and the operating time shorter.

Every case can be prepared with one of the sequences of HEROShaper[®] (chosen according to the difficulty), but when additional difficulties occur, specific instrumentation with the EndoFlare[™] and HERO Apical[®], can be used to remove interferences and facilitate treatment in a more efficient manner.

Acknowledgments

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Further reading

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